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Fatigue Assessment: Subjective Peer-to-Peer Fatigue Scoring (Reprint)

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14. ABSTRACT

Fatigue is a complex entity with contributing factors that may include insufficient sleep, circadian dysrhythmia, high workload, extended duty periods, clinical sleep pathology, psychosocial aspects, environmental factors, and many others. It can contribute to significant performance deficits and crucial safety lapses. Despite maximal implementation of accepted techniques and best practices for mitigation strategies, the deployed military rotary-wing (RW) environment must still contend with substantial fatigue-related issues among aircrew. We introduce a novel subjective peer-to-peer fatigue rating system recently demonstrated in a deployed military RW environment. Each pilot provides an anonymous weekly fatigue rating for every other pilot in the unit exclusive of self. Median and variance of the peer ratings for each pilot are recorded by the safety officer and tracked over time. The program allows for a multidimensional external perspective on a pilot's fatigue state, relative function, and degree of coping.
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Scoring is predicated upon the recognition of a significant deviation from a peer's baseline that may include social and interpersonal interactions or the observation of deficits in duty performance. The research basis for scientific validity and reliability regarding current peer fatigue scoring systems is exiguous. This novel approach may be of merit, particularly among military aircrew in a deployed-type setting with sustained high workload, operational stress, and limited time for supernumerary tasks. An anonymous subjective peer-to-peer fatigue scoring system is worthy of further scientific investigation, particularly warranting studies of reliability and validity.

Fatigue Assessment: Subjective Peer-to-Peer Fatigue Scoring

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Introduction: Fatigue is a complex entity with contributing factors that may include insufficient sleep, circadian dysrhythmia, high workload, extended duty periods, clinical sleep pathology, psychosocial aspects, environmental factors, and many others. It can contribute to significant performance deficits and crucial safety lapses. Despite maximal implementation of accepted techniques and best practices for mitigation strategies, the deployed military rotary-wing (RW) environment must still contend with substantial fatigue-related issues among aircrew. ***Methods:*** We introduce a novel subjective peer-to-peer fatigue rating system recently demonstrated in a deployed military RW environment. Each pilot provides an anonymous weekly fatigue rating for every other pilot in the unit exclusive of self. Median and variance of the peer ratings for each pilot are recorded by the safety officer and tracked over time. ***Results:*** The program allows for a multidimensional external perspective on a pilot's fatigue state, relative function, and degree of coping. Scoring is predicated upon the recognition of a significant deviation from a peer's baseline that may include social and interpersonal interactions or the observation of deficits in duty performance. ***Discussion:*** The research basis for scientific validity and reliability regarding current peer fatigue scoring systems is exiguous. This novel approach may be of merit, particularly among military aircrew in a deployed-type setting with sustained high workload, operational stress, and limited time for supernumerary tasks. An anonymous subjective peer-to-peer fatigue scoring system is worthy of further scientific investigation, particularly warranting studies of reliability and validity.

Keywords: rotary-wing fatigue, fatigue rating, subjective fatigue, aviation fatigue.

FATIGUE IS A complex entity with contributing factors that may include insufficient sleep, circadian dysrhythmia, high workload, extended duty periods, clinical sleep pathology, psychosocial aspects, environmental factors, and many others (3,7,8). Many recognize that it is now virtually a ubiquitous problem among our fast-paced 24/7 working society (2,14) and sleepiness/fatigue is the largest identifiable and preventable cause of mishaps among all modes of transport (3,14). Within the purview of aviation, fatigue can be a killer. It contributes to significant performance deficits and crucial safety lapses, and has been implicated in numerous, tragically consequential mishaps.

While most aeromedical experts recognize the important role of fatigue in aviation safety and flight performance, the compelling tasks of predicting dangerous fatigued states and quantifying risk and associated performance deficits have been immoderately difficult. This is particularly true for an individual functioning within the complex flight environment. Indeed, even a precise definition of fatigue has been somewhat recondite. It is often stratified into acute versus chronic or mental, physical, and psychomotor, while many purists elect to confine the entity to sleepiness resulting from circadian rhythm and homeostatic sleep drive (7). The International Civil Aviation Organization defines crewmember fatigue as "A physiological state of reduced mental or physical performance capability resulting from sleep loss or extended wakefulness, circadian phase, or workload (mental and/or physical activity) that can impair a crewmember's alertness and ability to safely operate an aircraft or perform safety related duties" (10). Friedl provides a useful military operational definition as "the state of reduced human performance capability due to inability to continue to cope with physiological stressors" (8). In both instances, it is worthy of note that fatigue is not merely a physiological state to be endured, but rather, by definition, a state of diminished performance and capability.

The scientific community has made great strides in understanding the neurobiological basis for sleepiness and fatigue, as well as potential performance deficits associated with fatigued states. There are many biomathematical models in current use with most fundamentally influenced by the two or three-process model (7,9,12). Yet models are subject to many limitations. Dawson and colleagues note the issues of individual variability, initial parameterization, psychosocial determinants, construct validity, and others (7). Thus, models have potential to be of great value, but also lack many independent variables that may be important in fatigue and related predicted performance.

Well-controlled, objective measures of fatigue-related performance deficits have great scientific value for reliability and validity. However, it is difficult to translate many highly specific laboratory-based neurocognitive or psychomotor experimental tests into a useful, comprehensive tool conducive to quantitative risk assessment and decision making. This is especially true for the

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broad and complex skill sets required for flight safety. Subjective rating scales are not without scientific merit (1) and there are many self-report instruments for fatigue assessment with varying degrees of complexity and validity (6,13). Two well-known validated subjective fatigue/sleepiness scales include the Samn-Perelli Checklist and the Karolinska Sleepiness Scale (10,15). Yet self-assessments of fatigue-related performance deficits can be notoriously poor (6,16,17).

Fatigue mitigation strategies for aviation have been well-described (2,4,5). Despite maximal implementation of accepted techniques and best practices, the deployed military rotary-wing environment must still contend with substantial fatigue-related issues among aircrew. The dynamic, kinetic, sustained, and often unpredictable nature of the operational environment limits the effectiveness of many fatigue tools and countermeasures. Given that fatigue is incompatible with high-level duty performance, aircrew health, and aviation safety, a simple and rapid fatigue assessment tool was sought by the British military rotary-wing community to further aid in fatigue risk management. A limited trial was initiated in a deployed environment for a peer-to-peer fatigue rating system to address this requirement. Based upon literature searches and to our knowledge, we are unaware of previous employment of this type of program.

METHODS

We introduced a novel subjective peer-to-peer fatigue rating system. Each pilot provided an anonymous weekly fatigue rating score for every other pilot in the unit exclusive of self. Situation depending, another regular specified time interval may be substituted. Median and variance of the peer ratings for each pilot are recorded (and protected) by the safety officer and reported to the chain of command. Fatigue ratings are tracked over time. The scoring system is a simple 1-10 Likert-type scale with guidelines for each rank to promote uniformity of subjective assessments (**Table I**). It is possible to use other scales, as well, such as a modified 1-7 Samn-Perelli score (10,15).

TABLE I. LIKERT-TYPE SCALE WITH GUIDELINES FOR PEER-TO-PEER FATIGUE SCORING.

Fatigue Score	Guidance§
1-2	No discernable issues; adequate coping
3-4	Slight fatigue effects with minimal impact/detriment
5-6	Fatigue effects observed; potential to influence judgement/decision making and/or manifest as performance deficits
7-8	Fatigue-related deficits observed; active mitigation required
9-10	Unfit to fly or engage in safety-critical tasks

§ Fatigue-related manifestations may include any of the following: impaired accuracy, concentration, and timing; diminished attention or difficulty with divided tasks; acceptance of errors and lower standards of performance; excessive yawning, nodding off, or 'spacing out'; increased requirement for caffeine; poor motivation; deterioration of mood and attitude; or marred social interaction and irritability.

Successful implementation of the peer-to-peer fatigue scoring system is dependent upon close relationships established among aircrew (e.g., a deployed or similar setting whereby crews spend a considerable measure of time together both on and off duty). Aircrews must develop a strong sense of each other's "baseline." Scoring is then predicated upon the recognition of a significant deviation from this baseline. This may include social and interpersonal interactions (e.g., motivation, mood, attitude, communication) or the observation of deficits in duty performance (e.g., errors and impaired accuracy, poor concentration and timing, diminished attention). Anonymity promotes honesty and protection from possible peer repercussions (real or perceived), and enhances effective safety reporting culture.

RESULTS

In deference to operational and security considerations, we are unable to provide actual pilot or unit fatigue data during deployment. However, presented is a notional case of Pilot A, a member of a squadron of 20 aviators (i.e., 19 weekly scores), through 12 wk of fatigue scoring (**Fig. 1**) with weekly median score and variance. Elevated individual pilot scores are taken under consideration by the safety and commanding officers (in addition to other methods of unit fatigue assessment and risk management). Mitigating efforts may include reduction in flying hours, scheduled time off, reassignment of duties or tasks, or other measures as appropriate. Elevated scores may also alert flight supervisors and commanders to personal problems and issues that can outwardly manifest similarly to fatigue-related effects.

Likewise, senior commanders of multiple units may review a composite score for each subordinate squadron (e.g., weekly mean score and variance of all pilots for each subordinate unit). Scores are not intended to be definitively diagnostic. Just as screening tests are designed to be sensitive but not necessarily specific, elevated scores prompt further attention and investigation. Furthering the analogy to screening tests, the peer-to-peer method is used in combination with other vehicles of fatigue assessment (both formal and informal), just as two simultaneous tests gives a net gain in sensitivity (but a net loss in specificity). The program leverages leader commitment, continuous monitoring processes, safety reporting, and sharing of information—all tenets of an effective safety management system (10).

DISCUSSION

It was the intent to establish a scoring system that was simple, relatively easy to execute, and required minimal aircrew time. Recognizing that an individual's self-awareness of fatigue-related impairment can be fallacious, the peer-to-peer system allows for an external multidimensional perspective on a pilot's fatigue state, relative function, and degree of coping. It is subject to a number of limitations: the research basis for scientific validity and reliability regarding peer fatigue scoring systems is limited. Furthermore, recognizing a significant

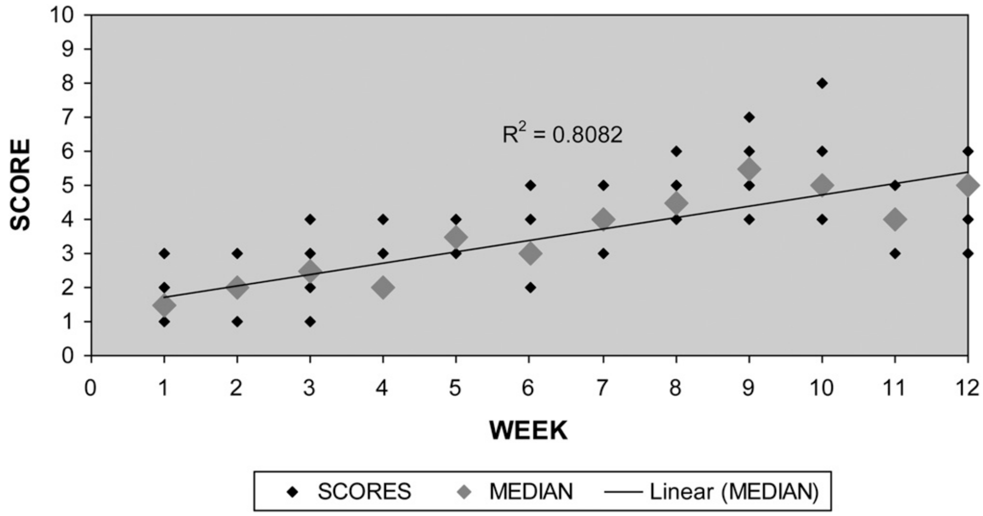

Fig. 1. Notional 12-wk peer-to-peer fatigue scoring for Pilot A (of 20-pilot squadron) demonstrating cumulative time effect on fatigue.

'deviation' from baseline necessarily requires the peer to have considerable familiarity with the scored pilot; this does not work well with new members to the unit or with individuals that 'internalize' to a considerable degree. This can be particularly problematic in motivated aircrew whereby individuals remain outwardly stoical with a 'crack-on' attitude despite a considerable amount of workload, fatigue, and stress. Individuals outwardly displaying such a sure and self-controlled composure to peers may result in artificially low scoring. In fact, a calm, phlegmatic posture under pressure can be seen as a desirable personal quality for aircrew selection. Such personalities would still be subject to the external observations of peers regarding fatigue-related deficits in duty performance, however. Furthermore, it has been described that group or peer fatigue may also impair cognitive functions necessary to identify manifestations of fatigue in colleagues (11).

It has been our experience that aircrew have expressed satisfaction with this type of program in a deployed setting. Many squadrons have noted that there was a gradual movement from an initial reactive-type posture to fatigue management within the unit to a more proactive mode over time with continued use. This was especially true with longitudinal tracking and matching elevated scores with iterative key events. Aircrew noted that an anonymous vehicle through which to report fatigue-related concerns was desirable. Furthermore, aircrew felt that this program kept the issue of fatigue (and associated potential for flight-safety implications) visible to the executive and germane to risk management. A recent aviation safety inspection of deployed units highlighted the program as an "area of evident strength" with recommendations to extend to maintenance personnel (Air Safety Assurance Team Leader; personal communication; 2013).

Fatigue is a multicomponent, complex entity. For all its shortcomings, this system is intended only to provide an additional perspective to decisions regarding fatigue risk management. It is not intended to function as a predictive model or comprehensive 'go-no go' assessment of fatigue state and associated performance-related deficits. Nonetheless, a simple, multiperspective peer fatigue assessment tool is highly desirable in some instances, particularly among hard-pressed military aircrew in a deployed-type setting with sustained high workload, operational stress, and limited time for supernumerary tasks. We believe an anonymous subjective peer-to-peer fatigue scoring system is worthy of further scientific investigation, particularly warranting studies of reliability and validity.

DISCLAIMER

The views, opinions, and/or findings contained in this report are those of the authors and should not be construed as an official UK Ministry of Defence or U.S. Department of Defense position, policy, or decision, unless so designated by other official documentation. There are no financial or other relationships that may be perceived as a conflict of interest.

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